

## CLAIMS

What is claimed is:

1 1. A processor implemented data processing method comprising:  
2 identifying a first plurality of regions within a first recursively  
3 partitioned/nested geometric structure that correspond to a first plurality of  
4 normalized multi-dimensional data of a first normalized multi-dimensional data  
5 space, the first recursively partitioned/nested geometric structure being  
6 corresponding to the first normalized multi-dimensional data space;  
7 determining corresponding first graphing values for said first corresponding  
8 regions within said first recursively partitioned/nested geometric structure  
9 determined for said first normalized multi-dimensional data of said first normalized  
10 multi-dimensional data space;  
11 associating corresponding first visual attributes with said first corresponding  
12 regions within said first recursively partitioned/nested geometric structure, based at  
13 least in part on corresponding ones of said determined first graphing values; and  
14 displaying said first recursively partitioned/nested geometric structure, visually  
15 differentiating said first corresponding regions based at least in part on  
16 corresponding ones of said associated first visual attributes.

1 2. The method of claim 1, wherein each of said first normalized multi-  
2 dimensional data of said first normalized multi-dimensional data space comprises a  
3 plurality of relative coordinate values, and the method further comprises constructing  
4 a polynary string to represent each of said first normalized multi-dimensional data  
5 and its corresponding one of said first regions within said first recursively

6 partitioned/nested geometric structure in accordance with the relative coordinate  
7 values.

1 3. The method of claim 2, wherein said constructing of a polynary string to  
2 represent each of said first normalized multi-dimensional data and its corresponding  
3 one of said first regions within said first recursively partitioned/nested geometric  
4 structure in accordance with the relative coordinate values comprises selecting a  
5 symbol as the next symbolic member of the polynary string based on which of the  
6 relative coordinate values is the current highest relative coordinate value.

1 4. The method of claim 3, wherein said constructing of a polynary string to  
2 represent each of said first normalized multi-dimensional data and its corresponding  
3 one of said first regions within said first recursively partitioned/nested geometric  
4 structure in accordance with the relative coordinate values further comprises  
5 reducing the highest relative coordinate value in by an amount (G), upon each  
6 selection, and reducing the amount (G) after each reduction.

1 5. The method of claim 4, wherein the amount (G) initially equals  $1 - F$ , and  
2 thereafter reduced each time by  $G \cdot (1 - F)$ , where  $F$  equals  $(n - 1)/n$ , and  $n$  equals  
3 the number of relative coordinate values.

1 6. The method of claim 2, wherein said determining of corresponding first  
2 graphic values comprises determining frequencies of occurrence of the various  
3 polynary strings of said first normalized multi-dimensional data, and assigning the  
4 determined frequencies of occurrence to the corresponding first regions within the

5 first recursively partitioned/nested geometric structure as the determined first  
6 graphing values of the corresponding first regions.

1 7. The method of claim 1, wherein said determining of corresponding first  
2 graphic values comprises assigning first output values corresponding to the first  
3 normalized multi-dimensional data as the determined first graphing values of the  
4 corresponding first regions within the first recursively partitioned/nested geometric  
5 structure.

1 8. The method of claim 7, wherein said determining of corresponding first  
2 graphic values further comprises computing said first output values.

1 9. The method of claim 8, wherein each of said first normalized multi-  
2 dimensional data of said first normalized multi-dimensional data space comprises a  
3 polynary string having a plurality of symbols, encoding a plurality of relative  
4 coordinate values, and said computing of the first output values comprises  
5 for each constituting symbols of a polynary string, summing one or more  
6 appearance values corresponding to one or more appearances of the particular  
7 symbol in the polynary string, and adding the sum to an average residual relative  
8 coordinate value.

1 10. The method of claim 9, wherein each appearance value corresponding to an  
2 appearance of a particular symbol is dependent on the position of the particular  
3 appearance of the particular symbol in the polynary string.

1 11. The method of claim 10, wherein each appearance value corresponding to an  
2 appearance of a particular symbol is equal to a positional value associated with the  
3 position of the particular appearance in the polynary string.

1 12. The method of claim 11, wherein  
2 each positional value equals to  $(1 - F) \times F^{(k - 1)}$ , and  
3 the average residual relative coordinate value equals  $(1 - F) \times F^K$ ,  
4 where F equals  $(n - 1)/n$ ,  
5 k denotes a position in a polynary string,  
6 n equals the number of relative coordinate values, and  
7 K equals the length of the polynary string.

1 13. The method of claim 2, wherein the method further comprises  
2 receiving a first zooming specification comprising one or more of said  
3 polynary string constituting symbols;  
4 excluding a first subset of said first regions based at least in part on said  
5 received first zooming specification; and  
6 repeating said displaying for the remaining ones of said first regions in an  
7 expanded manner.

1 14. The method of claim 13, wherein the method further comprises  
2 receiving a second zooming specification comprising one or more additional  
3 ones of said polynary string constituting symbols;  
4 excluding a second subset of said remaining ones of said first regions based  
5 at least in part on said received second zooming specification; and  
6 repeating said displaying for the remaining ones of said first regions.

1 15. The method of claim 14, wherein the method further comprises  
2 receiving an unzoom specification;  
3 restoring the remaining ones of said first regions to re-include said excluded  
4 second subset of said first regions; and  
5 repeating said displaying for the remaining ones of said first regions.

1 16. The method of claim 13, wherein the method further comprises  
2 receiving an unzoom specification;  
3 restoring the remaining ones of said first regions to re-include said excluded  
4 first subset of said first regions; and  
5 repeating said displaying for said first regions.

1 17. The method of claim 1, wherein said associating comprises for each of said  
2 first regions, associating a selected one of a plurality of symbols with the region  
3 based at least in part on the determined graphing value of the region.

1 18. The method of claim 1, wherein said associating comprises for each of said  
2 first regions, associating a selected one of a plurality of color attributes with the  
3 region based at least in part on the determined graphing value of the region.

1 19. The method of claim 1, wherein said associating comprises for each of said  
2 first regions, associating a selected one of a plurality of colored geometric primitives  
3 with the region based at least in part on the determined graphing value of the region.

1 20. The method of claim 1, wherein said associating comprises for each of said  
2 first regions, associating a selected blending of a plurality of colors with the region  
3 based at least in part on contributions to the determined graphing value of the  
4 region.

1 21. The method of claim 1, wherein said first regions correspond to all  
2 constituting regions of the first recursively partitioned/nested geometric structure,  
3 said first normalized multi-dimensional data are values of independent variables of a  
4 function, and said first graphing values are corresponding values of a dependent  
5 variable of the function.

1 22. The method of claim 1, wherein the method further comprises  
2 identifying a second plurality of regions within a second recursively  
3 partitioned/nested geometric structure that correspond to a second plurality of  
4 normalized multi-dimensional data of a second normalized multi-dimensional data  
5 space, the second recursively partitioned/nested geometric structure being  
6 corresponding to the second normalized multi-dimensional data space;  
7 determining corresponding second graphing values for said second  
8 corresponding regions within said second recursively partitioned/nested geometric  
9 structure determined for said second normalized multi-dimensional data of said  
10 second normalized multi-dimensional data space;  
11 associating corresponding second visual attributes with said second  
12 corresponding regions within said second recursively partitioned/nested geometric  
13 structure, based at least in part on corresponding ones of said determined second  
14 graphing values; and

15 displaying said second recursively partitioned/nested geometric structure,  
16 visually differentiating said second corresponding regions based at least in part on  
17 corresponding ones of said associated second visual attributes.

1 23. The method of claim 22, wherein said first and second recursively  
2 partitioned/nested geometric structures are displayed in a manner such that both  
3 recursively partitioned/nested geometric structures are visible concurrently.

1 24. The method of claim 23, wherein each of said first and second normalized  
2 multi-dimensional data of said first and second normalized multi-dimensional data  
3 spaces comprises a polynary string having a plurality of symbols, encoding a  
4 plurality of relative coordinate values, the method further comprises  
5 receiving a first zooming specification comprising one or more of said  
6 polynary string constituting symbols;  
7 excluding a first subset of said first regions based at least in part on said  
8 received first zooming specification;  
9 excluding a second subset of said second regions based at least part on the  
10 removed ones of said first regions; and  
11 repeating said displaying for the remaining ones of said first and second  
12 regions.

1 25. The method of claim 22, wherein said first and second normalized multi-  
2 dimensional data are values of first and second input variables.

26. The method of claim 22, wherein said first normalized multi-dimensional data are values of input variables, and said second normalized multi-dimensional data are values of corresponding output variables.

27. The method of claim 1, wherein the method further comprises computing a location for a centroid for each of a plurality primitive elements of the geometric structure.

28. The method of claim 27, wherein coordinates  $(x_p, y_p)$  of the location of each centroid is computed as follows:

$$X_p = X_c + R * \sum_{k=1}^K V(N, k) * C(N, m[L_k])$$

$$Y_p = Y_c + R * \sum_{k=1}^K V(N, k) * S(N, m[L_k])$$

where:

$(X_c, Y_c)$  are coordinate values of the geometric structure's centroid;

R is a radius extending from the geometric structure's centroid to an outermost vertex of the geometric structure;

$V(N, k)$  is  $w * (1 - w) ** (k - 1)$  where  $w = 1 / (1 + \sin(\pi / N))$ ;

$m[L_k]$  is outer vertex number (1, 2, ..., N) assigned to the kth symbol appearing in a corresponding polynary string;

$C(N, m[L_k]) = \cos(a * \pi)$ ; and

$S(N, m[L_k]) = \sin(a * \pi)$  [where  $a = (5 * N - 4 * m[L_k]) / (2 * N)$ ].

29. The method of claim 28, wherein the K values of  $V(N, k)$  are computed once responsive to a specification of N.



1 30. The method of claim 28, wherein at least the N values of  $C(N, m[L_k])$  or the N  
2 values of  $S(N, m[L_k])$  are computed once responsive to a specification of N.

1 31. A processor implemented data processing method for generating a polynary  
2 string representation for an entity defined by n relative coordinate values, n being an  
3 integer, comprising:

4 associating n symbolic representations with said n relative coordinate values;  
5 and

6 selecting the symbolic representation corresponding to the highest relative  
7 coordinate value as the first constituting member of the polynary string  
8 representation.

1 32. The method of claim 31, wherein the method further comprises  
2 computing a constant value (F) by dividing  $(n - 1)$  by n; and  
3 computing a variable value (G) by subtracting F from 1;  
4 subtracting G from the current highest relative coordinate value; and  
5 selecting the symbolic representation corresponding to the current highest  
6 relative coordinate value as the next constituting member of the polynary string  
7 representation.

1 33. The method of claim 32, wherein the method further comprises  
2 multiplying the current value of G by F;  
3 subtracting G from the current highest relative coordinate value; and  
4 selecting the symbolic representation corresponding to the current highest  
5 relative coordinate value as the next constituting member of the polynary string  
6 representation.

1 34. The method of claim 33, wherein the method further comprises repeating  
2 said multiply, subtracting and selecting operations set forth in claim 29.

1 35. The method of claim 31, wherein said symbolic representation comprises a  
2 letter.

1 36. The method of claim 31, wherein said symbolic representation comprises a  
2 special character.

1 37. A processor implemented data processing method for generating a relative  
2 coordinate value for an constituting variable of an entity, the entity being  
3 represented by a polynary string representation having a plurality of symbolic  
4 members representing the constituting variables, the method comprising:  
5 determining appearance positions of appearance instances of the symbolic  
6 members in said polynary string representation;  
7 summing positional values corresponding to the appearance instances of the  
8 symbolic members in said polynary string representation; and  
9 adding the sum to an average residual relative coordinate value.

1 38. The method of claim 37, wherein  
2 each positional value equals to  $(1 - F) \times F^{(k - 1)}$ , and  
3 the average residual relative coordinate value equals  $(1 - F) \times F^K$ ,  
4 where  $F$  equals  $(n - 1)/n$ ,  
5  $n$  equals the number of coordinate values,  
6  $k$  denotes a position in the polynary string representation; and

7 K equals the length of the polynary string.

1 39. An apparatus comprising:

2 storage medium having stored therein programming instructions designed to  
3 enable the apparatus to

4 identify a first plurality of regions within a first recursively

5 partitioned/nested geometric structure that correspond to a first

6 plurality of normalized multi-dimensional data of a first normalized

7 multi-dimensional data space, the first recursively partitioned/nested

8 geometric structure being corresponding to the first normalized multi-

9 dimensional data space,

10 determine corresponding first graphing values for said first corresponding

11 regions within said first recursively partitioned/nested geometric

12 structure determined for said first normalized multi-dimensional data of

13 said first normalized multi-dimensional data space;

14 associate corresponding first visual attributes with said first corresponding

15 regions within said first recursively partitioned/nested geometric

16 structure, based at least in part on corresponding ones of said

17 determined first graphing values, and

18 display said first recursively partitioned/nested geometric structure,

19 visually differentiating said first corresponding regions based at least in

20 part on corresponding ones of said associated first visual attributes;

21 and

22 at least one processor coupled to the storage medium to execute the

23 programming instructions.

1 40. The apparatus of claim 39, wherein each of said first normalized multi-  
2 dimensional data of said first normalized multi-dimensional data space comprises a  
3 plurality of relative coordinate values, and the programming instructions are further  
4 designed to enable the apparatus to construct a polynary string to represent each of  
5 said first normalized multi-dimensional data and its corresponding one of said first  
6 regions within said first recursively partitioned/nested geometric structure in  
7 accordance with the relative coordinate values.

1 41. The apparatus of claim 40, wherein said programming instructions are  
2 designed to enable the apparatus to perform said constructing of a polynary string  
3 by selecting a symbol as the next symbolic member of the polynary string based on  
4 which of the relative coordinate values is the current highest relative coordinate  
5 value.

1 42. The apparatus of claim 41, wherein said programming instructions are further  
2 designed to enable the apparatus to perform said constructing of a polynary string  
3 by reducing the highest relative coordinate value in by an amount (G), upon each  
4 selection, and reducing the amount (G) after each reduction.

1 43. The apparatus of claim 42, wherein said programming instructions are  
2 designed to enable the apparatus to set the amount (G) initially to  $1 - F$ , and  
3 thereafter reduced each time by  $G \cdot (1 - F)$ , where  $F$  equals  $(n - 1)/n$ , and  $n$  equals  
4 the number of relative coordinate values.

1 44. The apparatus of claim 40, wherein said programming instructions are  
2 designed to enable the apparatus to perform said determining by determining

3 frequencies of occurrence of the various polynary strings of said first normalized  
4 multi-dimensional data, and assigning the determined frequencies of occurrence to  
5 the corresponding first regions within the first recursively partitioned/nested  
6 geometric structure as the determined first graphing values of the corresponding first  
7 regions.

1 45. The apparatus of claim 39, wherein said programming instructions are  
2 designed to enable the apparatus to perform said determining by assigning first  
3 output values corresponding to the first normalized multi-dimensional data as the  
4 determined first graphing values of the corresponding first regions within the first  
5 recursively partitioned/nested geometric structure.

1 46. The apparatus of claim 45, wherein said programming instructions are further  
2 designed to enable the apparatus to perform said determining by computing said  
3 first output values.

1 47. The apparatus of claim 46, wherein each of said first normalized multi-  
2 dimensional data of said first normalized multi-dimensional data space comprises a  
3 polynary string having a plurality of symbols, encoding a plurality of relative  
4 coordinate values, and said programming instructions are designed to enable the  
5 apparatus to perform said computing by  
6 summing one or more appearance values corresponding to one or more  
7 appearances of the particular symbol in a polynary string, and adding the sum to an  
8 average residual relative coordinate value, and  
9 repeating said summing and adding for each constituting symbols of the  
10 polynary string.

1 48. The apparatus of claim 47, wherein each appearance value corresponding to  
2 an appearance of a particular symbol is dependent on the position of the particular  
3 appearance of the particular symbol in the polynary string.

1 49. The apparatus of claim 48, wherein each appearance value corresponding to  
2 an appearance of a particular symbol is equal to a positional value associated with  
3 the position of the particular appearance in the polynary string.

1 50. The apparatus of claim 49, wherein  
2 each positional value equals to  $(1 - F) \times F^{**}(k - 1)$ , and  
3 the average residual relative coordinate value equals  $(1 - F) \times F^{**}K$ ,  
4 where  $F$  equals  $(n - 1)/n$ ,  
5  $k$  denotes a position in a polynary string,  
6  $n$  equals the number of relative coordinate values, and  
7  $K$  equals the length of the polynary string.

1 51. The apparatus of claim 40, wherein said programming instructions are further  
2 designed to enable the apparatus to  
3 receive a first zooming specification comprising one or more of said polynary  
4 string constituting symbols;  
5 exclude a first subset of said first regions based at least in part on said  
6 received first zooming specification; and  
7 repeat said displaying for the remaining ones of said first regions in an  
8 expanded manner.

1 52. The apparatus of claim 51, wherein said programming instructions are further  
2 designed to enable the apparatus to  
3 receive a second zooming specification comprising one or more additional  
4 ones of said polynary string constituting symbols;  
5 exclude a second subset of said remaining ones of said first regions based at  
6 least in part on said received second zooming specification; and  
7 repeat said displaying for the remaining ones of said first regions.

1 53. The apparatus of claim 52, wherein said programming instructions are  
2 designed to enable the apparatus to  
3 receive an unzoom specification;  
4 restore the remaining ones of said first regions to re-include said excluded  
5 second subset of said first regions; and  
6 repeat said displaying for the remaining ones of said first regions.

1 54. The apparatus of claim 51, wherein said programming instructions are further  
2 designed to enable the apparatus to  
3 receive an unzoom specification;  
4 restore the remaining ones of said first regions to re-include said excluded  
5 first subset of said first regions; and  
6 repeat said displaying for said first regions.

1 55. The apparatus of claim 39, wherein said programming instructions are  
2 designed to enable the apparatus to perform said associating by associating, for  
3 each of said first regions, a selected one of a plurality of symbols with the region  
4 based at least in part on the determined graphing value of the region.

1 56. The apparatus of claim 39, wherein said programming instructions are  
2 designed to enable the apparatus to perform said associating by associating, for  
3 each of said first regions, a selected one of a plurality of color attributes with the  
4 region based at least in part on the determined graphing value of the region.

1 57. The apparatus of claim 39, wherein said programming instructions are  
2 designed to enable the apparatus to perform said associating by associating, for  
3 each of said first regions, a selected one of a plurality of colored geometric  
4 primitives with the region based at least in part on the determined graphing value of  
5 the region.

1 58. The apparatus of claim 39, wherein said programming instructions are  
2 designed to enable the apparatus to perform said associating by associating, for  
3 each of said first regions, a selected blending of a plurality of colors with the region  
4 based at least in part on contributions to the determined graphing value of the  
5 region.

1 59. The apparatus of claim 39, wherein said first regions correspond to all  
2 constituting regions of the first recursively partitioned/nested geometric structure,  
3 said first normalized multi-dimensional data are values of independent variables of a  
4 function, and said first graphing values are corresponding values of a dependent  
5 variable of the function.

1 60. The apparatus of claim 39, wherein said programming instructions are further  
2 designed to enable the apparatus to



3 identify a second plurality of regions within a second recursively  
4 partitioned/nested geometric structure that correspond to a second plurality of  
5 normalized multi-dimensional data of a second normalized multi-dimensional data  
6 space, the second recursively partitioned/nested geometric structure being  
7 corresponding to the second normalized multi-dimensional data space;  
8 determine corresponding second graphing values for said second  
9 corresponding regions within said second recursively partitioned/nested geometric  
10 structure determined for said second normalized multi-dimensional data of said  
11 second normalized multi-dimensional data space;  
12 associate corresponding second visual attributes with said second  
13 corresponding regions within said second recursively partitioned/nested geometric  
14 structure, based at least in part on corresponding ones of said determined second  
15 graphing values; and  
16 display said second recursively partitioned/nested geometric structure,  
17 visually differentiating said second corresponding regions based at least in part on  
18 corresponding ones of said associated second visual attributes.

1 61. The apparatus of claim 60, wherein said first and second recursively  
2 partitioned/nested geometric structures are displayed in a manner such that both  
3 recursively partitioned/nested geometric structures are visible concurrently.

1 62. The apparatus of claim 61, wherein each of said first and second normalized  
2 multi-dimensional data of said first and second normalized multi-dimensional data  
3 spaces comprises a polynary string having a plurality of symbols, encoding a  
4 plurality of relative coordinate values, said programming instructions are further  
5 designed to enable the apparatus to

6 receive a first zooming specification comprising one or more of said polynary  
7 string constituting symbols;  
8 exclude a first subset of said first regions based at least in part on said  
9 received first zooming specification;  
10 exclude a second subset of said second regions based at least part on the  
11 removed ones of said first regions; and  
12 repeat said displaying for the remaining ones of said first and second regions.

1 63. The apparatus of claim 60, wherein said first and second normalized multi-  
2 dimensional data are values of first and second input variables.

1 64. The apparatus of claim 60, wherein said first normalized multi-dimensional  
2 data are values of input variables, and said second normalized multi-dimensional  
3 data are values of corresponding output variables.

1 65. The apparatus of claim 39, wherein said apparatus is a selected one of a  
2 palm sized processor based device, a notebook computer, a desktop computer, a  
3 set-top box, a single processor server, a multi-processor server, and a collection of  
4 coupled servers.

1 66. The apparatus of claim 37, wherein said programming instructions are further  
2 designed to compute a location for a centroid for each of a plurality of primitive  
3 elements of the geometric structure.

1 67. The apparatus of claim 66, wherein said programming instructions are  
2 designed to compute coordinates ( $x_p$ ,  $y_p$ ) of the location of each centroid as follows:

$$Xp = Xc + R * \sum_{k=1}^K V(N, k) * C(N, m[Lk])$$

$$Yp = Yc + R * \sum_{k=1}^K V(N, k) * S(N, m[Lk])$$

where:

(X<sub>c</sub>, Y<sub>c</sub>) are coordinate values of the geometric structure's centroid;

R is a radius extending from the geometric structure's centroid to an outermost vertex of the geometric structure;

V(N, k) is  $w * (1 - w) ** (k - 1)$  where  $w = 1 / (1 + \sin(\pi / N))$ ;

m[L<sub>k</sub>] is outer vertex number (1, 2, ..., N) assigned to the kth symbol appearing in a corresponding polynary string;

C(N, m[L<sub>k</sub>]) = cosine(a \* π); and

S(N, m[L<sub>k</sub>]) = sine(a \* π) [where  $a = (5 * N - 4 * m[L_k]) / (2 * N)$ ].

68. The apparatus of claim 67, wherein said programming instructions are designed to compute the K values of V(N, k) once responsive to a specification of N.

69. The method of claim 67, wherein said programming instructions are designed to compute at least the N values of C(N, m[L<sub>k</sub>]) or the N values of S(N, m[L<sub>k</sub>]) once responsive to a specification of N.

70. An apparatus comprising  
storage medium having stored therein programming instructions designed to enable the apparatus to  
associate n symbolic representations with said n relative coordinate values, and

6 select the symbolic representation corresponding to the highest  
7 relative coordinate value as the first constituting member of the  
8 polynary string representation; and  
9 at least one processor coupled to the storage medium to execute the  
10 programming instructions.

1 71. The apparatus of claim 70, wherein the programming instructions further  
2 enable the apparatus to  
3 compute a constant value (F) by dividing  $(n - 1)$  by  $n$ ; and  
4 compute a variable value (G) by subtracting F from 1;  
5 subtract G from the current highest relative coordinate value; and  
6 select the symbolic representation corresponding to the current highest  
7 relative coordinate value as the next constituting member of the polynary string  
8 representation.

1 72. The apparatus of claim 71, wherein the programming instructions further  
2 enable the apparatus to  
3 multiply the current value of G by F;  
4 subtract G from the current highest relative coordinate value; and  
5 select the symbolic representation corresponding to the current highest  
6 relative coordinate value as the next constituting member of the polynary string  
7 representation.

1 73. The apparatus of claim 72, wherein the programming instructions further  
2 enable the apparatus to repeat said multiply, subtracting and selecting operations  
3 set forth in claim 64.

1 74. The apparatus of claim 70, wherein said symbolic representation comprises a  
2 letter.

1 75. The apparatus of claim 70, wherein said symbolic representation comprises a  
2 special character.

1 76. The apparatus of claim 70, wherein said apparatus is a selected one of a  
2 palm sized processor based device, a notebook computer, a desktop computer, a  
3 set-top box, a single processor server, a multi-processor server, and a collection of  
4 coupled servers.

1 77. An apparatus comprising:  
2 storage medium having stored therein a plurality of programming instructions  
3 designed to enable the apparatus to  
4 determine appearance positions of appearance instances of symbolic  
5 members of a polynary string representation of an entity having a  
6 number of constituting variables, the symbolic members being  
7 corresponding to the constituting variables,  
8 sum positional values corresponding to the appearance instances of the  
9 symbolic members in said polynary string representation, and  
10 add the sum to an average residual relative coordinate value; and  
11 at least one processor coupled to the storage medium to execute the  
12 programming instructions.

1 78. The apparatus of claim 77, wherein

2 each positional value equals to  $(1 - F) \times F^{k-1}$ ; and  
3 the average residual relative coordinate value equals  $(1 - F) \times F^K$ ,  
4 where  $F$  equals  $(n - 1)/n$ ,  
5  $n$  equals the number of coordinate values,  
6  $k$  denotes a position in the polynary string representation; and  
7  $K$  denotes the length of the polynary string.

1 79. The apparatus of claim 77, wherein said apparatus is a selected one of a  
2 palm sized processor based device, a notebook computer, a desktop computer, a  
3 set-top box, a single processor server, a multi-processor server, and a collection of  
4 coupled servers.